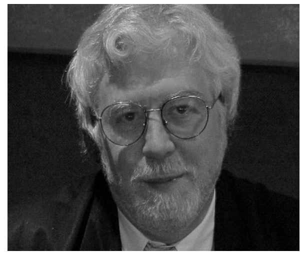
THE ROLE OF SIMULATING COMMODITY BASED FREIGHT NETWORKS IN ESTIMATING THE NATIONAL BENEFITS OF INTRODUCING PERFORMANCE BASED STANDARD VEHICLES INTO AUSTRALIA

Graduate of the Australian National University in Canberra. PhD and Masters Research Degrees in Logistics Productivity. Director Industrial Logistics Institute and Chair National Truck Accident Research Centre.



K. HASSALL
University of Melbourne
Australia

Abstract

In 1999 the then National Road Transport Commission (NRTC) in Australia re-launched the concept of Performance Based Standards (PBS) for road freight vehicles. In 2010 the now National Transport Commission sought an evaluation of the national benefits for the take up of PBS. The solution to this problem nationally was through a combination of a) simulation modelling of road freight commodity networks linked to b) back end regression techniques. This simulation and econometric approach became the framework for the national benefit cost analysis. The observation that the physical networks traversed by trucks are very distinctive for different commodities is important in realistically calculating the benefits of seeding PBS vehicles into existing fleets. Examining these commodity networks, now worked with a mix of conventional and PBS vehicles, forms a new approach in the analysis of road transport productivity, for both long distance and urban freight. The results, based on this network simulation approach, is a template for many nations to use. From the aspect of sustainability and efficiency this case study is instructive.

Hit Words: *Performance Based Standards, High Productivity Vehicles, road freight Optimization, Road Freight efficiency, Road transport productivity*.

1. BACKGROUND

Australia reinvigorated the concept of Performance Based Standards (PBS) which put in place a new regulatory framework for developing safer and more productive trucks. These PBS trucks are often referred to as High Productivity Freight Vehicles (HPFVs) and the policy framework for the use of these vehicles was developed by the then National Road Transport Commission (NRTC), which is now know as the National Transport Commission.(NTC) (NRTC 1999a, NRTC 1999b). These new types of PBS vehicles are being trialled in Australia the Netherlands, Canada, New Zealand, South Africa and in Scandinavia.

This analysis details the benefits associated with the implementation of a unified national regulatory approach in adopting the Performance Based Standards (PBS) allowing these new high productivity vehicles onto Australian road networks. The timeframe for the analysis was taken as 20 years. This timeframe was chosen as it is very similar to the timeframe for adoption and existing integration of the B-Double in Australia, from their initial operational trials to recently released data (ABS, 2011). In 1986 just seven of these B-Double vehicles were being trialled but by 2010 there were approximately 15,500 such vehicles operating in Australia.

2. The MAKE UP of the ROAD TRANSPORT INDSTRY and the POTENTIAL for PBS

The Australian road transport industry, as are most road transport industries, is divided into two major sectors, the 'hire and reward' sector, often known as 'for hire', and the 'ancillary' sector which is also known as the 'own account' sector. As the name suggests, the for-hire sector moves other customers' goods for money whilst the ancillary sector moves freight, generated by its own industry, with a range of internal payment systems. The farmer with a truck, the small manufacturer that delivers his own goods, are examples of ancillary operators. However, all ancillary operators are not small: for example, Australia Post, Fonterra, as well as elements of the fleets operated by companies such as Boral and Woolworths are examples of ancillary operators. Even some chemical and tanker companies will be owned by their parent manufacturing corporations, and only carry company generated freight. These larger ancillary operators will also often avail themselves of hire and reward sub-contractors. The truck population breakdown between ancillary and for hire operators is presented in Table 1, which also reflects the rigid and articulated split between these two areas of control.

Table 1: Segmentation of the Australian truck fleet > 4.5 T GVM

Truck Type	Ancillary	For Hire	Sub-Total	%
Rigid	159,926	82,707	**242,633**	**79.4**
Articulated	16,422	46,540	**62,962**	**20.6**
Sub-Total	**176,348**	**129247**	**305,595**	
%	**57.7%**	**42.3%**		

Source: ABS SMVU 2006 (detailed)

Table 2 reflects the fleet structure by local industry grouping. Although this analysis has examined, and used, specific vehicle populations split by hire and reward and ancillary operations, some further data was not available to allow more precise kilometre averages by vehicle types and by hire and reward and ancillary operations. However, vehicle populations could be grouped by the classifications of hire and reward and ancillary operations, and by rigid and articulated vehicle numbers within these same classifications. It is very likely that the fleets with 20 or more vehicles might well consider a PBS option in the future.

2.1 Calculating the Benefits of PBS

The Australian Bureau of Statistics reports in the very detailed data cubes the activity of specific vehicle configurations through the former annual Survey of Motor Vehicle Use. This visible classification of vehicles is useful but how they are used will depend, significantly on what commodities are carried, and the usual types of delivery networks the vehicles are used for. For example, forestry trucks bringing logs back from the harvest site and returning for another load is very different to the delivery pattern of a small express parcel truck delivering several bags of express articles to several clients in a CBD setting. Similarly a livestock carrier moving animals several hundred kilometres for processing is not comparable to a petroleum tanker delivering to several service stations per delivery run. Comparing a farmer delivering his grain to a rail head over several days and almost ceasing to use the truck again for most of the year, perhaps averaging only 5,000 kilometres per annum, is different to a sub-contract linehaul operator performing some 300,000 kilometres per annum.

Table 2 proposes the physical fleet population by 2030. The 10 truck types in Bold Type are the prime candidates for PBS development to occur. PBS developments in these truck classes form the basis of the national PBS benefits.

What does PBS do for these operators? Vehicles deliver their goods to points in their respective types of networks. As discussed these could be quite dense urban networks with several hundred customers or a simpler linehaul network between four cities. The fleet operations manager decides to start incorporating PBS vehicles into the fleet. Because of the enhanced capability of these vehicles, extra volume and/or extra mass can be uplifted usually allowing fewer trips, thus fewer kilometres and fewer trucks to deliver the payloads. It is almost certain that seeding PBS vehicles into the fleet will have a reduction in total network kilometres and the number of vehicles needed to undertake the deliveries. Typically the metrics that reflect the physical productivity of PBS adoption are: a reduction in total kilometres, a reduction of total operational hours, a reduction in individual fleet vehicle numbers, and a statistically probable reduction in total severe accidents. The accident rates for PBS vehicles as a specific group are expected to be lower than for non PBS vehicles because of their higher engineered performance and improved stability. Similarly the reduction in network kilometres will see a proportional reduction in total fuel use although individual PBS vehicles will usually be slightly more fuel consumptive than their older non PBS counterparts. However, PBS take-up may have a flow on benefit to the wider ancillary sector and the second hand vehicle market.

2.2 The Take-up of PBS within Existing Fleets by Vehicle Type

As well as being benefits of diffusing PBS vehicles into a particular type of fleet there also needs to be estimates of the fraction that PBS vehicles that will populate of a particular vehicle class in the future. Table 4 presents these estimates for the Hire and Reward sector and the Ancillary sectors. These factors were achieved from a significant number of transport operator interviews.

Table 2: Estimated Vehicle Populations 2006 to 2030

PBS Level	*Bold Indicates Simulation categories* Truck Types	Simulation Group	Vehicles 2006	Ave Kms Per Vehicle	Vehicles 2030
	Rigid trucks: 2 axle: no trailer: GVM 4.5 to 7.0 tonne	1	**45230**	**17,092**	**54762**
	Rigid trucks: 2 axle: no trailer: GVM 7.0 to 12.0 tonne	2	**80926**	**23,708**	**97981**
1	**Rigid trucks: 2 axle: no trailer: GVM over 12.0 tonne**	**3**	39246	28,606	47517
1	**Rigid trucks: 2 axle: with trailer: GCM to 42.5 tonne**	**4**	13924	28,784	16858
	Rigid trucks: 3 axle: no trailer: GVM 4.5 to 18.0 tonne	5	**2106**	**13,485**	**2550**
1	**Rigid trucks: 3 axle: no trailer: GVM over 18.0 tonne**	**6**	40973	27,985	49608
	Rigid trucks: 3 axle: with trailer: GCM to 42.5 tonne	7	**5953**	**36,671**	**7208**
1	**Rigid trucks: 3 axle: with trailer: GCM over 42.5 tonne**	**8**	8127	68,307	9840
	Rigid trucks: 4 axle: no trailer: GVM 4.5 to 25.0 tonne	9	**532**	**19,957**	**644**
	Rigid trucks: 4 axle: no trailer: GVM over 25.0 tonne	10	**4621**	**45,973**	**5595**
	Rigid trucks: 4 axle: with trailer: GCM to 42.5 tonne	11	**108**	**77,477**	**131**
1	**Rigid trucks: 4 axle: with trailer: GCM over 42.5 tonne**	**12**	887	72,061	1074
	Articulated trucks: single trailer: 3 axle rig	13	**1597**	**24,108**	**2692**
	Articulated trucks: single trailer: 4 axle rig	14	**3673**	**40,627**	**6192**
	Articulated trucks: single 3 axle trailer: 5 axle rig	15	**1389**	**39,977**	**2342**
	Articulated trucks: single 2 axle trailer: 5 axle rig	16	**4883**	**45,937**	**8232**
	Articulated trucks: single 4 axle trailer: 6 axle rig	17	**103**	**0**	**174**
1	**Articulated trucks: single 3 axle trailer: 6 axle rig**	**18**	34279	83,177	57790
	Articulated trucks: B-double: to 8 axle rig	19	**1878**	**79,086**	**3940**
	Articulated trucks: B-double: over 8 axle rig	**20**	**8108**	**224,439**	**16921**
2b	**Super B-double**	**A**	**0**	**Estimate**	**Estimate**
3a	**B-triple**	**B**	**0 (SMVU)**	**Estimate**	**Estimate**
	Articulated trucks: Road train: 2 trailers	21	**3240**	**135,679**	**5462**
	Articulated trucks: Road train: 3 trailers	22	**1164**	**232,819**	**1962**
	Articulated trucks: single 2 axle trailer: over 6 axle rig	23	**14**	**98,500**	**24**
	Articulated trucks: single 3 axle trailer: over 6 axle rig	24	**1726**	**69,079**	**2910**
	Articulated trucks: single 4 axle trailer: over 6 axle rig	25	**516**	**33,798**	**870**
	Articulated trucks: to 6 axle rig (not elsewhere classified)	26	**392**	**31,857**	**661**
2b	**A-double**	**27**	**0**	**Estimate**	**Estimate**
2b	**Articulated Buses**	**28**	**277**	**50,744**	**335**
			305872		404274

Table 3: Estimates of PBS Take-up by Fraction of Vehicle Classes

PBS Level / Simulation Class	**Take-up** by 2030 % Take-up **H & R**	**Take-up** by 2030 % Take-up **Ancillary**
Level 1/ Simulation Category 3 Rigid (2AR>12T)	10.00%	2.00%
Level 1 / Simulation Category 4 Rigid (2AR+T)	15.00%	3.00%
Level 1/ Simulation Category 6 Rigid (3AR>18T)	10.00%	2.00%
Level 1/ Simulation Category 8 Rigid (3AR+T>42.5T)	10.00%	2.00%
Level 1/ Simulation Category 12 Rigid (4AR+T>42.5T)	15.00%	3.00%
Level 1/Single Articulated (19M to 20M)	10.00%	2.00%
Level 2b /Super B-double(<=30M)	15.00%	15.00%
Level 3a /B-triple(<=36.5M)[3]	30.00%	30.00%
Level 2b / A-double(<=30M)	2.50%	2.50%
Level 2b / Articulated Bus(<=30M)	15.0%	NA

It is expected that the take-up fraction for the Ancillary sector will be significantly less than for the for hire sector, and this has generally been estimated as a ratio of 1 in 5 with some exceptions, namely B-triples, Super B-doubles and A-doubles. In fact this ancillary take-up rate may be higher after the first 10 or 15 years of an enhanced PBS regime as many hire and reward operators will sell their second-hand PBS vehicles to ancillary operators. So the fraction reflecting the PBS take-up within the ancillary sector, is possible a large under-estimate for the period 2020 to 2030.
These above vehicle type and configurations were selected in the modelling as prime PBS candidates. However, PBS configurations are not exhaustive and there are several configurations and combinations that have not been examined here.

Explaining the PBS Fleet Take-up Rates f

By 2030 it was estimated that a fraction of the ten vehicle classes presented in Table 2 would be PBS vehicles.

Table 4: Interview Summaries for Some PBS Vehicle Types

Interview	Area	Vehicle Type	Comments
Operator 1	LH National Fleet	B-triple	Loss of Owner Driver BDs to BTs
Operator 2	LH Small Fleet	B-triple	Large Owner Driver Loss from BDs
Operator 3	Linehaul./Local	Super BD	60% to 70% to Container work
Operator 4	Linehaul	B-triple	15% maybe for some contracts
Operator 5	Urban	Quad Axle	Significant Mass work> 10%
Operator 6	Linehaul/Urban	B-triple, 4 Axle Rigids	BT 30% - 40%, 2AR > 50%,4AR >20%
Operator 7	Linehaul	B-triple, Pocket RT	BT 40% PRT 40%
Operator 8	Linehaul	B-triple	60% to 70% Uptake from BDs
Operator 9	Linehaul	B-triple	100% of BD Operations
Operator 10	Urban	Truck/Dog	Much greater than 1 in 7 with higher mass
Regulator Domestic	State	A-double Vehicles	Small Regional use, and some Urban
Regulator Foreign	National	BDs and Mini BTs	Take-up range 7% to 30%

Legend: BD = BDouble, BT = B triple,RT = Rpad Train, PRT = Pocket Road Train, 2AR = 2 axle rigid, 4AR = 4 Axle Rigid, Dom = Domestic, Int = No Domestic
Source: Industrial Logistics Institute, 2009

This would range between 2.5% of the existing B-double fleet becoming A-doubles, to 30% of the growth in B-double fleet becoming B-triples by 2030. These estimates were drawn from 11 operator phone or personal interviews conducted after the 1st July 2009, and drawing on a decade of consultation with industry which has generated several peer reviewed research papers prior this date.

2. PBS COMMODITY NETWORKED BASED SIMULATIONS – PRELIMINARY ANALYSIS

2.1 ` Undertaking the PBS Commodity Network Based

Over the period, from 2006 to 2009, some 15 PBS case studies were undertaken by simulating different truck types carrying different commodities across different types of operational networks. A limited number of these case studies were made available to the NTC at that time.

Table 5: Commodity Freight Classes that will take up PBS

Operational Commodity	Potential for PBS Take-up
Petroleum	Yes
Other Tanker / Chemicals	Yes
Quarry / earth / mining	Yes
Over Dimensional	Yes
Car Carrier	Yes
Volumetric parcels	Yes
Steel	Yes
Grain	Yes
Building Materials	Yes
Logging	Yes
Waste	Yes
Container/wharf	Yes
Agricultural Other	No
Taxi Trucks	Yes
Refrigerated Operations	Yes
General Freight Other	No
Concrete	Yes
Mini Skips	Yes
Furniture	Yes
Horse movements (long trailer)	Yes
General Retail	No
Livestock	Yes
Non Specialised Courier	No
Security Collections	Maybe

Source: Raptour Systems 2006e

The case studies were a first stage in the examination of the impact of PBS vehicles operating on different commodity networks. Further simulations were undertaken for this study.

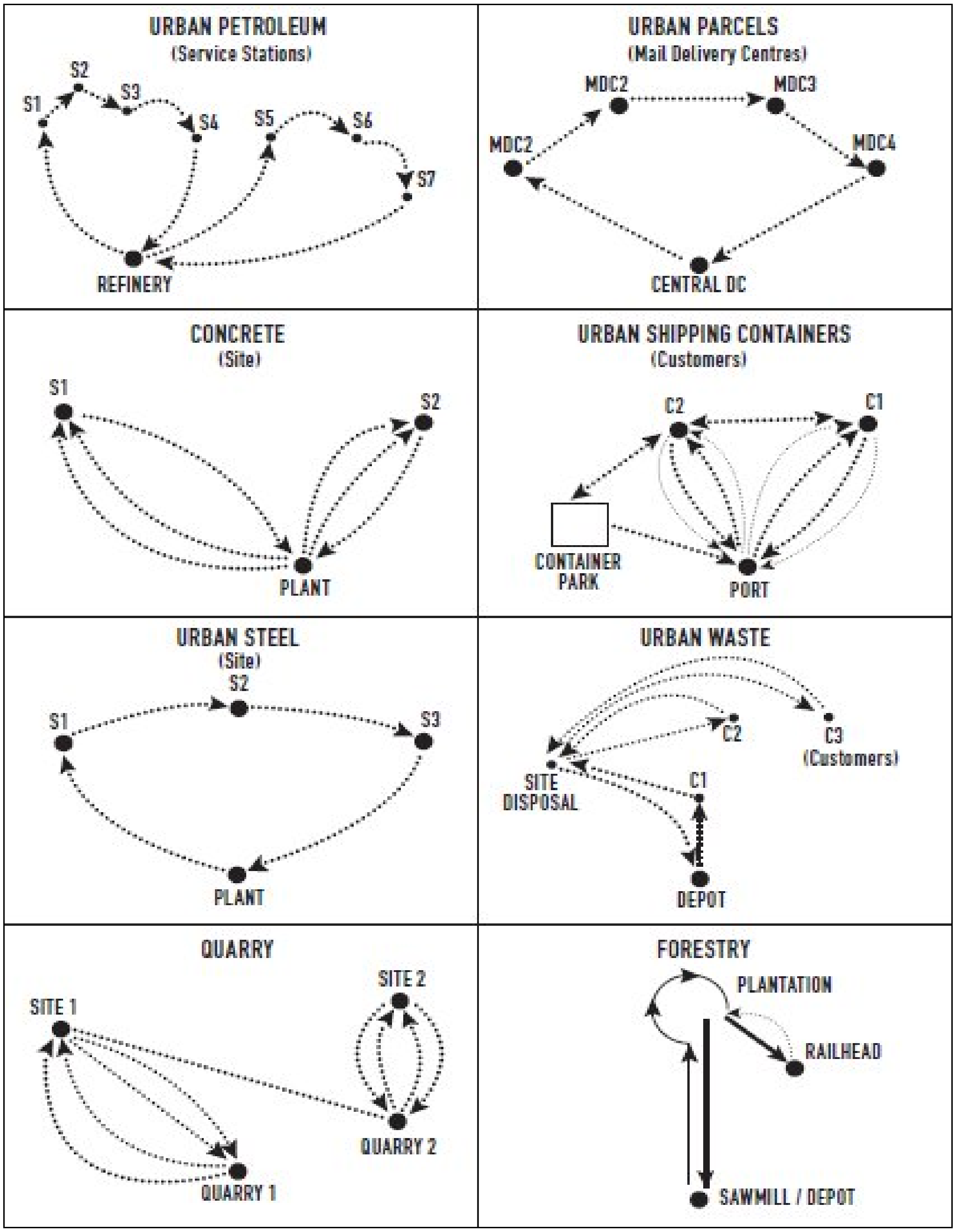


Figure 1: Freight Commodity Networks - examples

This allowed an estimate of the vehicle reduction factors by using the re arranged regression equation 1.Figure 1 depicts examples of what are called '*commodity based networks'*. These physical networks on which simulations have been undertaken in some two dozen commodity types will often have different outcomes when their operational commodity fleets take-up PBS vehicles.

Equation 1 was generated by running regression analysis on Data set 1. The calculation of the reduction factors for kilometres and vehicle numbers three data sets were used. Data set 1 was the 15 commodity based simulations which examined the relationship between kilometres, change in vehicle capacity and change in vehicle numbers. Because of the 15 elements in this data set several statistical regressions were run against this data. These regressions yielded a simplistic business rule that was useful in the application for data set 2, and data set 3.

Table 6: Data Set 1 for the Calculation of Vehicle and Kilometre Reduction Factors

Operation	Commodity	Kilometre Reduction Factor	Capacity Change	Vehicle Reduction Factor
Linehaul	Inter Capital Parcels	0.7840	0.3300	0.700
Linehaul	Furniture	0.8000	0.3300	0.800
Linehaul	Livestock	0.7545	0.3300	0.800
Regional	Forestry	0.6250	0.3300	0.534
Regional	Mineral Sands	0.7600	0.3300	0.750
Urban	Concrete	0.5590	1.0000	0.620
Urban	Urban Parcels	0.7390	0.4286	0.640
Urban	Intra Container Port	0.7490	1.0000	0.750
Urban	Outside Container Port	0.7500	0.3300	0.750
Urban	Steel Urban	0.8040	0.4800	0.670
Urban	General Parcels	0.8490	0.4280	0.778
Urban	Urban Mixed Fleets	0.8500	0.1590	0.889
Urban	Urban Tanker	0.9170	0.5100	0.875
Urban	Waste	0.8200	0.3300	0.720
Urban	Skips	0.7400	1.0000	0.750
Urban	Outside Container Port	0.5550	1.0000	0.556

Source: University of Melbourne and Industrial Logistics Institute: Simulations 2006 to 2009

Equation 1

New Vehicle Factor = (New Kilometre Factor +(0.10 x Capacity Change) - 0.25) / 0.75

Table 7: Simulation Reduction factors for Longer Distance PBS Vehicles

Area/Simulation	Commodity	KM Factor	Capacity Change	Vehicles
Linehaul1	Inter Capital Parcels	0.7840	0.3300	0.700
Linehaul2	Furniture	0.8000	0.3300	0.800
Linehaul3	Livestock	0.7545	0.3300	0.800
Regional1	Forestry	0.6250	0.3300	0.534
Regional2	Mineral Sands	0.7600	0.3300	0.750
	Average Linehaul / Regional	**0.7450**		**0.7167**

Source: Industrial Logistics Institute Simulations

The averages from the simulation data output are presented in Table 7 and Table 8 for long distance and urban operations respectively. It should be noted that the massive impact of container related Super B-doubles, urban case 11, was excluded from the average of the other 10 urban case averages, however, the results were used for that specific vehicle type in the financial benefits estimation. Excluding urban case 11 reflects a conservative approach to the benefits estimation derived from the simulation approach. The kilometre and vehicle reduction factors represent that level that kilometres and vehicle numbers will reduce through the introduction of PBS vehicles into a freight transport operation.

Table 8: Simulation Reduction factors for Some Urban PBS Vehicles

Area/Simulation	Commodity	KM Factor	Capacity Change	Vehicle Factor
Urban1	Concrete	0.5590	1.0000	0.620
Urban2	Parcels	0.7390	0.4286	0.640
Urban3	Containers Intra	0.7490	1.0000	0.750
Urban4	Intra Port BD	0.7500	0.3300	0.750
Urban5	Steel Urban	0.8040	0.4800	0.670
Urban6	Parcels	0.8490	0.4280	0.778
Urban7	City Operations	0.8500	0.1590	0.889
Urban8	Urban Tanker	0.9170	0.5100	0.875
Urban9	Waste	0.8200	0.3300	0.720
Urban10	Mini Skips	0.7400	1.0000	0.750
Urban11	Container SBD	0.4450	1.0000	0.4440
	Average[1]	0.747	0.606	0.717

Source: Industrial Logistics Institute Simulations

Table 8 and Table 9 generated their respective kilometre and vehicle reduction factors from similar simulation techniques. Table 9 data was supplied by an independent Victorian agency: the Victorian Freight and Logistics Council.

Table 9: Articulated PBS Kilometre and Vehicle Reduction Factors

Vehicle Type	**Commodity**	**Kms Reduction Factor [1].**	**Capacity change**	**Vehicle Reduction Factor**
Articulated	Grain	0.7000	0.5000	0.667
Articulated	Cubic Parcels	0.7800	0.2200	0.736
Articulated	Manufactures	0.7500	0.4000	0.720
Articulated	Milk Tanker	0.8500	0.2300	0.831
Articulated	General Freight	0.7500	0.3400	0.712
Articulated	Over Dimension	0.8500	0.2500	0.833
Articulated	Parcels	0.7000	0.5000	0.667
Articulated	Container	0.7500	0.3000	0.707
Articulated	Steel	0.8000	0.2500	0.767
Articulated	Container	0.6700	0.5000	0.627
Articulated	Container	0.6700	0.5000	0.627
	Average	**0.7518**		**0.7175**

Source: Victoria Freight and Logistics Council,(VFLC), 2008 (adapted Note 1. Rounded estimates)

Table 10: Rigid (Truck and Dogs) PBS Vehicles (km and vehicle factors)

Rigid	**Productivity**	**Est kilometre Reduction Factor**	**Capacity change**	**Est Vehicle reduction factor**
Urban	Heavy Quarry	0.800	0.4200	0.789
Urban	Light Truck and Dog	0.880	0.3300	0.884
	Average	**0.840**		**0.837**

Source: VFLC, 2008 (adapted)

The Table 10 Data Set was derived from actual PBS applications for the Truck and Dog class of vehicles. (Rigid trucks with trailers). Vehicle reduction factors were derived from Equation 1.

Equation 2

$$\textbf{New Total Kilometres} = 0.75 \times \textbf{New Vehicles} - (0.10 \times \textbf{Capacity Change}) + 0.25$$

Equation 3

$$\textbf{New Vehicles} = (\textbf{New Kilometres} + (0.10 \times \textbf{Capacity Change}) - 0.25) / 0.75$$

Equation 3 was again derived from the output of the urban commodity based simulations presented in Table 8.

Equation 4

$$\textbf{New Urban Kilometres} = 0.80 \times \textbf{New Urban Vehicles} - (0.12 \times \textbf{Capacity Change}) + 0.25$$

The savings for the longer distance operations, the urban operations and the truck and dog operations were used in the financial analysis. The exception being for the Super B-double which used simulation results across a 15% subset of the total urban articulated road transport task, which represented the container kilometre task for an example using the City of Melbourne, including vehicle operations being full, partly loaded or empty. It is certain that Super B doubles will also carry other commodities besides containers, so this was again a conservative assumption and should be revisited.

2.2 The Financial Benefits of PBS

The financial benefits of PBS were generated from applying the vehicle class take-up rate, divided by the total 20 year period, to estimate the number of PBS vehicles likely to emerge in that year. The PBS vehicle reduction factor is applied to a fraction of the vehicle population that will take up PBS. A reduction comes about as fewer PBS vehicles will be required to undertake a proportion of the task that would have been done by non PBS vehicles.

The expected number of new PBS vehicles will also generate kilometre savings when the PBS kilometre factor is applied to the expected number of kilometres generated by that group of PBS vehicles. This reduction in kilometres is the basis for the benefits of PBS. The saved kilometres times the $/per kilometre rate for hire and reward and for ancillary operators is applied to their respective sectoral vehicle populations in each vehicle class for that year. It should be noted that generally ancillary operator costs are lower than the for hire operators as labour need not be fully paid against an award, eg a farmer, and generally trucks are older and therefore the operating cost profiles will also have a lower capital component.

This process is repeated by vehicle class, each year, with the costs being escalated by the adjusted TransEco cost index.

The full PBS benefits by take-up vehicle type are presented in Table 12.

Equation 5

$$\text{\$ PBS Savings} = \sum_{PBSv} \sum_{n} \left[(\text{Kms saved}) * (\text{\$/km Orig Veh Kms}) - \text{PBS Kms} * (\text{PBS \$/km} - \text{Orig Veh \$/km}) \right]$$

The growth in vehicles – rigid, articulated, or B-double class, is applied to the next year's vehicle population, and the process of new PBS vehicles is re-estimated, and the kilometre savings generated by these vehicles recalculated. This process is continued for the 11 vehicle classes that have been targeted for PBS take-up, over the 20 year period 2001 to 2030. The vehicle operating costs are presented in Appendix B. The highest dollars per kilometre rates are not necessarily for the largest vehicles but can also be incurred by low, or very low, average kilometre vehicles.

The above equation suggests that there are kilometre savings in the original vehicle kilometres but this is offset somewhat by the extra cost of running PBS vehicles. This calculation is performed across each year from 2011 to 2030 and across all potential PBS vehicle types.

Table 11: Direct Operating Benefits of PBS Options, by Vehicle Class

PBS Vehicle type	$ Savings
Rigid trucks: 2 axle: no trailer: GVM over 12.0 tonne	$270,028,079
Rigid trucks: 2 axle: with trailer: GCM to 42.5 tonne	$128,447,799
Rigid trucks: 3 axle: no trailer: GVM over 18.0 tonne	$421,102,673
Rigid trucks: 3 axle: with trailer: GCM over 42.5 tonne	$130,294,818
Rigid trucks: 4 axle: with trailer: GCM over 42.5 tonne	$24,139,103
Articulated trucks: single 3 axle trailer: 6 axle rig	$425,947,589
Super B-double	$704,711,545
B-triple	$3,060,210,825
A-double	$280,010,185
Articulated Buses	$7,881,125
Total	$5,452,773,742

Industrial Logistics Institute estimates

3. PBS 'FLOW-ON ECONOMIC EFFECTS' – The INPUT-OUTPUT METHODS

3.1 Application of the Input-Output Method

The input-output system has found extensive use especially in economic forecasting and planning, both in the short and in the long run. It is especially useful in examining the impact of sub-sectors of the economy on the entire economy as a whole. In this case the use of I/O methods was used to estimate the flow on impacts of the savings generated by PBS to the rest

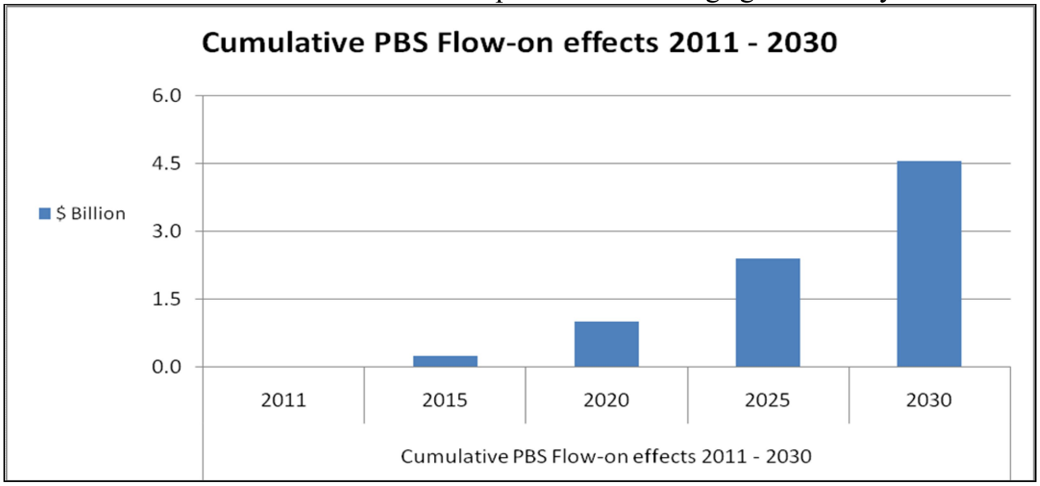


Figure 2: Cumulative Flow-on Effects to Other Industries ($ billion nominal)

Source: ESAC 2009

of the economy. The method has proved particularly effective in the analysis of sudden and large changes or other far-reaching transformations of an economy. In brief this extensive analysis was not included in the Benefit Cost Analysis but is outlined here as being an adjunct benefit which is not explored in this paper.This I/O method suggests that PBS also delivers a considerable benefit to the other non road transport sectors of the economy. Also the benefits from the analysis are certainly low as only the Hire and Reward flow-on benefits have been modelled.

CONCLUSION

Table 12 presents the impacts and savings in nominal terms for introducing PBS vehicles into Australia for the 20 year period 2011 to 2030.In brief the introduction of 13,848 vehicles will save some 4,362 existing type vehicles becoming operational. There will be a 3.7 billion kilometer saving . Total operational savings will approach 5.5 billion dollars with a further economic flow on of $4.5 billion in value added terms.

Table 12: Summary Benefits of Australian PBS for 2011 - 2030

PBS Metrics	Impact
PBS Vehicles at 2030	13,848
PBS Vehicle Savings at 2030	4,362
PBS Vehicle Savings % of fleet at 2030	1.1%
PBS Vehicle as % Fleet at 2030	3.5%
PBS Kilometre Savings 2011 - 2030	3.7 Billion kms
PBS Kilometres at 2030	1.44 Billion kms
% PBS Kilometres at 2030	6.60%
Financial Savings ($) 2011 - 2030	$5.45B
Flow on Impacts ($) 2011 - 2030	$4.57B
Total Operational and Financial Impacts	**$10.02B**

Industrial Logistics Institute and ESAC Estimates

The estimation of this result was derived though the use of simulation tools looking at the impacts of seeding PBS vehicles onto commodity based networks. This is a new research area that warrants further investigation from both a freight efficiency and productivity perspective. The physical commodity networks provide a new template for PBS analysts to use nationally.

Appendix 1: Weighted Unit Costs per Kilometre

Table A1 reflects the weighted averages of vehicle costs in dollars per kilometre. The PBS and non PBS unit costs are a weighted average of for hire unit costs and ancillary unit costs. These two sectors are weighted by the population of vehicles in the class for each sector. In some instances the ancillary operator will have similar operating costs to the for hire operator but in most cases ancillary operating costs are lower than the for hire counterpart as labour is not costed at all against the transport operation, and capital equipment is based on the take up of a second hand vehicle.

Table A1: Unit Rates by Vehicle Class for PBS and non PBS Vehicles

PBS Level / Simulation Group	Ave Kms	PBS $/km[1]	Non PBS $/Km[1]
Level 1 / Cat 3	28,606	2.11	1.92
Level 1 / Cat 4	28,784	2.21	2.01

Level 1 / Cat 6	27,985	2.68	2.44
Level 1 / Cat 8	68,307	3.15	2.86
Level 1 / Cat 12	72,061	3.14	3.00
Level 1 / Single Articulated	83,177	1.55	1.54
Level 2b / Super B-double	35,000	3.21	2.69
Level 3a / B-triple	224,439(e)	1.66	1.66
Level 2b / A-double	224,439(e)	1.76	1.76
Level 2b / Articulated Bus	50,744 (e)	3.87	3.60

Source: 1. Translog unpublished databases
(e) Estimated

Appendix 2: Vehicle Growth Rates and deflators to 2030

The long term growth rates were calculated by examining the macro vehicle classes from 1971 to 2007 adjusted for rigid trucks below 4.5 tonnes and for non freight carrying articulated and rigid vehicles. The B-double growth rate calculated was not from their beginnings in 1986 which would yield a compound growth rate of 39% per annum, but instead from a stable level since 2004 when B-doubles have been at a steady level of 15.2% of SMVU articulated truck totals. This B-double percentage within the total articulated truck population was carried through till 2030. Many observers may argue that this B-double growth rate may be much higher but again this forecast was considered conservative, but it should be noted that any B-triple introduction will also cut into the existing growth in the B-double market.

Table A2: Annual Vehicle Growth Factors 2008 to 2030

B-double, A-double, B-triple growth rates p.a	**1.032**
Single Articulated Trucks growth rates p.a	**1.022**
Rigid Trucks growth rates p.a	**1.008**
Road Transport Cost Escalators	**1.0299**
NPV Discount Rate	**1.07**
Cost of Life escalator	**1.03**
CO2 market escalator	**1.07**

Source: Industrial Logistics Institute 2009

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GLOSSARY

BD B-double
BT…B-triple
AD…A-double
CO_2 Carbon Dioxide
DFD Department of Finance and Deregulation
ESAC Economic and Statistical Analysis Canberra
GVM…Gross Vehicle Mass
H&R…Hire and Reward
ILI Industrial Logistics Institute
I/O…Input-Output
NTC…National Transport Commission
NPV Nett Present Value
NTC…National Transport Commission
p.a. Per Annum
SBD Super B-double
SMVU…Survey of Motor Vehicle Use
PBS Performance Based Standards
L Linehaul Operations
R Regional Operations
U...Urban Operations
2AR…2 Axle Rigid Truck
3AR…3 Axle Rigid Truck
4AR…4 Axle Rigid Truck
2AR + T…2 Axle Rigid Truck plus Trailer
3AR + T…3 Axle Rigid Truck plus Trailer
4AR + T…4 Axle Rigid Truck plus Trailer